European Space Agency

A manned outpost in space for research and exploration

Europe's key role in operating and exploiting the ISS

European engineering ability and industrial expertise lies at the heart of the International Space Station (ISS), a unique technological accomplishment and a shining example of international cooperation.

The Space Station – the largest civilian cooperative project ever conceived – is the creation of five international partners representing 14 nations.

This first-ever human outpost in Earth orbit is extending the boundaries of exploration, science, technology and medicine in new and exciting directions.

"Europe's involvement through ESA in the Space Station partnership is a story of major technological and scientific achievement," said Simonetta Di Pippo, ESA Director of Human Spaceflight.

"As well as its scientific and technological goals, the ISS is a triumph for international cooperation, allowing Europe to play a key role and work closely with the United States, Russia, Japan and Canada."

ESA's contributions include the world-class multi-purpose science and technology facility called the Columbus laboratory, and the highly sophisticated Automated Transfer Vehicle (ATV), one of the most advanced spacecraft ever built and launched.

Other essential ISS components from Europe include two connecting modules (Nodes 2 and 3), the European Robotic Arm (ERA) and Cupola, an astronaut's workstation and spectacular 'room with a view'.

"Technology and research are shaping our world and will play an increasingly important role in shaping our future," explained Simonetta Di Pippo.

The launch and attachment of the Columbus laboratory in 2008 demonstrated the capabilities Europe has gained in developing human-rated orbital infrastructure and undertaking major scientific programmes in weightlessness – all of which ultimately leads to benefits for people on Earth.

Europe's role was strengthened by the successful five-month mission in 2008 of the first Automated Transfer Vehicle (ATV), dubbed Jules Verne after the French novelist. Jules Verne was the first in a series of at least five ATVs. This was a premiere for Europe, whose logistic spacecraft performed flawlessly bringing supplies to the ISS, reboosting its orbit and conducting a safe destructive re-entry.

With the assembly of the ISS now close to completion, Europe and its partners are entering a time when they can make full use of the Station.

The introduction of permanent six-person crew significantly increases the time available for science and technology activities allowing humanity to at last fulfil the age old dream of living and working in space.

"Europe's involvement through ESA in the ISS has been and continues to be a story of major technological and scientific achievement," added Simonetta Di Pippo. "It has been a great stimulus for European industry, which developed and manufactured cutting-edge space systems that have performed flawlessly on orbit."

Simonetta Di Pippo, ESA Director of Human Spaceflight.

ISS Info

Partners	US, Russia, Europe, Japan, Canada
Laboratories	Five
Permanent crew	Six from 2009
Altitude	Approximately 400 km above to Earth
Inclination	51.6° to the Equator
Orbit	90 minutes to circle Earth
Dimensions	Truss length: 108 m Line of modules: 80 m
Mass (weight)	Approximately 420 tonnes
Living volume	Approximately 935 m³

ESA German astronaut Hans Schlegel works on the exterior of the Columbus module during the STS-122 mission in February 2008.

Essential Space Station operations and supplies

Europe is engaged in a series of high-profile missions that has seen ESA extend its role in supporting both the construction and future operation of the International Space Station (ISS).

After the six-month ISS flight of Thomas Reiter ('Astrolab') and the Space Shuttle mission of Christer Fuglesang ('Celsius') in 2006 came the flight of ESA's Italian astronaut Paolo Nespoli and his 'Esperia' mission.

As a mission specialist on the STS-120 Space Shuttle flight, he supervised the deployment and installation of the European-built connecting module Node 2, called Harmony.

The cylindrical Node 2 paved the way for attaching Europe's own research laboratory, Columbus, and a similar Node 3 (Tranquility) is to follow on an ISS assembly mission at the beginning of next year.

The Nodes were built in Italy for NASA as part of a barter agreement with ESA and provide important resources for connecting and operating the Space Station, as well as water processing and oxygen generation for the US segment and stowage space for equipment racks.

The Columbus laboratory was carried into orbit on Shuttle mission STS-122 along with ESA's French astronaut Leopold Eyharts and Hans Schlegel from Germany in February 2008.

During the 10-year projected lifespan of Columbus, Earth-based researchers – assisted by members of the ISS crew – will conduct hundreds of experiments in the fields of life sciences, materials science, fluid physics and many other disciplines, all in weightlessness.

"The ISS and Europe's involvement in it is one of the biggest success stories in the history of spaceflight," said Bernardo Patti, ESA's ISS Programme Manager.

"Europe now has its own permanent, inhabited 'real-estate' in space. The Columbus laboratory will produce the outstanding science for which it was built and will help us to prepare for future human exploration missions."

In 2010 Europe will launch the second in a series of Automated Transfer Vehicles (ATV) on an Ariane-5 rocket from the European spaceport in French Guiana. This one is named after Johannes Kepler.

An 11 m long European Robotic Arm (ERA) supplied by ESA is also to be installed on the ISS and used for the maintenance of solar arrays, inspections and replacement tasks on the Russian segment of the Station.

One of the final elements in the construction cycle, is installation of the European-built Cupola, an observation and control module, which will be attached to Node 3 after launch by the Space Shuttle early in 2010.

Cupola will provide the ISS crew with a panoramic viewpoint for guiding operations outside the Space Station and observing the Earth, as well as accommodating command and control workstations, and other hardware.

By the time the Space Station reaches its planned completion at the end of 2010, hardware developed and built in Europe will have been launched on almost half of the assembly missions, and European astronauts will be regular crew members.

In addition to all the hardware, a vast ground segment has been developed from which ESA and industrial staff operate Columbus and the ATV.

ESA's Columbus laboratory attached to the Space Station.

ISS opens doorways to practical research

Understanding Earth

Astronauts in orbit and experiments attached to the outside of the Space Station are able to observe the Earth over long periods of time, allowing us to watch large-scale changes in the environment and better understand how our planet works.

Stepping stone to the stars

We already know that living in weightlessness leads to the weakening of bones and muscles – so if humans are ever going to travel to planets like Mars we must understand the effects of such long journeys on the human body. The Space Station allows scientists to study these effects and provide solutions for long-duration space travel. Countermeasures to these problems find immediate applications to cure illness and help with the effects of ageing, assisting millions of people on Earth.

Medical advances

Chemical reactions behave differently without the influence of gravity and this means that molecules can be blended and substances created that would be impossible on Earth. Such experiments may lead to possible treatments for diabetes, AIDS, cancer and improved organ transplants. Observing the long-term effects of microgravity on humans in space also teaches us more about everyday biological processes back on Earth.

New materials

The Space Station is a unique environment in which to create new materials, where the conditions of weightlessness allow scientists to study physics, combustion science, fluid flow, crystal growth and the solidification of metal alloys in completely new ways. Such experiments may lead to new industrial products and processes that can be used effectively on Earth.

Advances in life support technology

Scientist have already developed many new technologies for the Space Station that they believe will someday help people living on Earth. Technology with future potential includes computer software, lower-cost and energy efficient heating and cooling systems, air and water purification systems, and advances in communications. All these new technologies will help improve living conditions on Earth and contribute to sustainable development.

Versatile craft plays vital role

ESA's Automated Transfer Vehicle (ATV) has a highly essential mission. The versatile craft is a true multi-purpose service vehicle for the Space Station, acting as a cargo carrier, storage facility and as a 'tug' craft.

After its launch by a special version of Europe's Ariane-5 heavy lift rocket, the ATV automatically approaches and docks with the Space Station where it can remain for up to six months.

Each ATV flight is operated by a dedicated European control centre (ATV-CC) on the premises of the French Space Agency CNES in Toulouse, France.

As well as being used for the transport of supplies and equipment, its pressurised area becomes valuable extra working and stowage space for the ISS crew.

The engines of the ATV can also be fired periodically to help maintain the Space Station's correct orbital altitude.

At the end of its useful life in orbit, the ATV is filled with rubbish and waste before being undocked and sent on a re-entry trajectory that ensures it burns up harmlessly over the ocean.

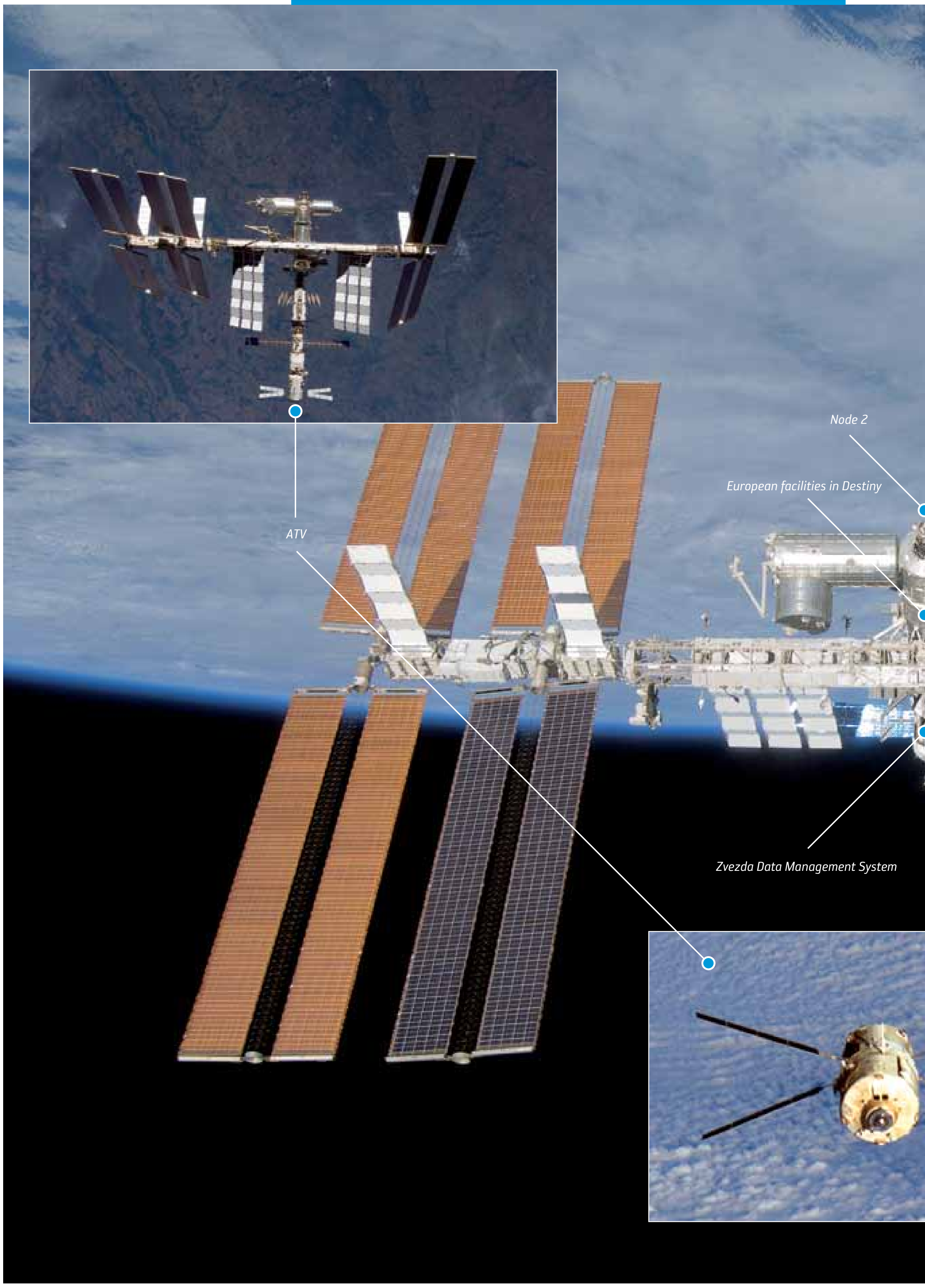
"The ATV is much more that a spaceship," said ESA's ATV Project Manager Nico Dettman. "It is a cargo ship, a module, a rocket and two spacecraft all rolled into one."

The ATV's role as a key ISS logistics vehicle becomes even more important after the US Space Shuttle is retired in 2010 and ESA is also studying developments to enhance its future capabilities further.

One scenario would involve replacing the ATV cargo carrier with a cargo re-entry capsule, equipped with a heatshield and therefore able to bring back to Earth hundreds of kilograms of cargo and valuable experiments.

Such a project – named the Advanced Re-entry Vehicle (ARV) – would use heritage from ESA's Atmospheric Re-entry Demonstrator (ARD), which flew successfully in 1998, as well as the work done in the definition of past space transportation system concepts.

In the future the European ATV may evolve to have roles beyond that of a cargo carrying craft.



European elements of the In

Columbus

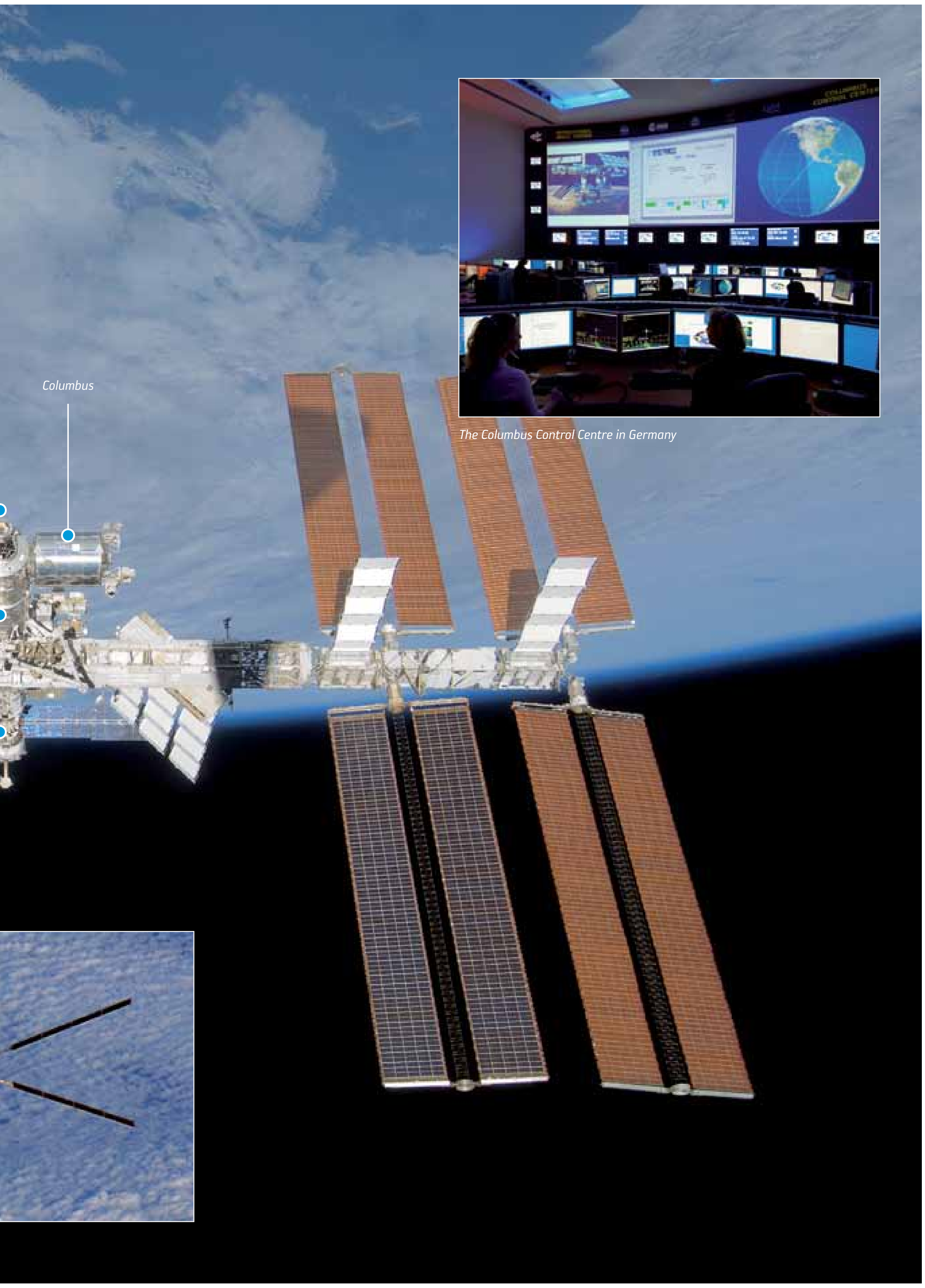
The Columbus laboratory, ESA's biggest single contribution to the Space Station, has space for 10 state-of-the-art experiment racks, which include Biolab, the Fluid Science Laboratory, the European Physiology Modules, the multi-functional European Drawer Rack, the Microgravity Science Glovebox (MSG) and NASA's Human Research Facility. The exterior has four platforms for technology experiments, Earth observation and space science observations.

Robotic Arm

The 11 m long European Robotic Arm (ERA) will be launched to the ISS on the Russian Multipurpose Laboratory Module. Among its many uses will be the installation of solar arrays, and inspections and assembly tasks on the Russian segment of the ISS.

Nodes 2 and 3

These cylindrical components (6.7 m in length by 4.5 m in diameter) are the vital connecting joints between laboratories and docking ports for visiting spacecraft. Each also has an inside section for equipment racks and stowage.



The Columbus Control Centre in Germany

ternational Space Station

Observation post

The European-built Cupola is an observation and control module to be attached to the Harmony Node 3. As well as containing command and control workstations and other hardware, it will provide orbiting astronauts with a panoramic viewpoint – both for guiding operations outside the Space Station and observing Earth.

Frank De Winne.

Zvezda Data Management System

ESA-supplied computers perform overall control of the Russian ISS elements, as well as guidance and navigation for the entire Space Station. The Data Management System (DMS-R), as the system is known, is literally the 'brain' of the Russian Zvezda module.

European facilities in Destiny

Major European research payloads, including the Portable Pulmonary Function System, the Minus 80 degree centigrade Laboratory Freezer, and the Materials Science Lab, are installed in the US Destiny laboratory.

Automated Transfer Vehicle

ESA's ATV is the largest orbiting space vehicle after the US Space Shuttle and plays a vital role in Space Station servicing. It has the capability to re-supply the ISS with up to 7.5 tonnes of propellants and cargo. Although people are not launched in ATVs, astronauts can access its cargo, working space and systems during the six months each vehicle is docked to the ISS.

Unique science opportunities

Leopold Eyharts moves equipment whilst setting up Columbus after its installation on the ISS.

The Columbus laboratory – the first permanent European research facility in space – is the cornerstone of innovation and research in space for the nations of Europe.

Since delivery to the Station in 2008 it has been consistently increasing the acquisition of scientific data across a multitude of disciplines.

Results of these experiments, which are funded by European science programmes, will have a direct impact on future European space activities and many will ultimately bring benefits to people all over the world.

The general design and layout of the Columbus module is similar to the three multi-purpose logistics modules (MPLM) built by the Italian space agency (ASI) and used for transporting scientific experiments, materials and supplies to the Space Station via the Space Shuttle.

But unlike the visiting logistic modules that return to Earth in the cargo bay of the Shuttle, the Columbus laboratory is a permanent part of the orbiting outpost. Columbus connects to the rest of the Space Station via the Harmony Node 2 module.

Its flexibility provides the capability for ground-based researchers, aided by the Station's crew, to conduct hundreds of experiments in life sciences, materials sciences, fluid physics and other research areas that benefit from the conditions of weightlessness.

Experiments that need to be exposed to open space can be conducted outside the module, thanks to four exterior mounting platforms.

The Columbus laboratory has its own dedicated control centre located at the German Aerospace Center (DLR) in Oberpfaffenhofen, Germany.

From here, ground controllers can communicate with the module as the Space Station orbits the Earth, as well as with researchers distributed across Europe and in the United States and Russia.

Scientists can monitor and interact with their experiments onboard via nine dedicated User Support and Operations Centres (USOC) located in various European countries. The USOCs are instrumental when it comes to the preparation and the real-time execution of experiments.

The big picture

ESA's Cupola is destined to become a favourite location of crew members of the International Space Station (ISS).

This control post with a panoramic view is a dome-shaped module with windows that will help astronauts observe and guide operations outside the Space Station.

The pressurised observation and work area also accommodates command and control workstations and other hardware.

Spacewalking activities can be observed from the Cupola whilst visiting spacecraft and external areas of the ISS can be monitored from the 360 degree view, which is expected to offer important psychological benefits to crew members.

With a clear view of Earth and celestial bodies, the Cupola will also be used for a variety of scientific applications in Earth observation and space science.

The Cupola weighs 1.8 tonnes and is about two metres in diameter and 1.5 metres high. It has six trapezoidal side windows and a circular top window of 80 cm in diameter, making this the largest window ever flown in space.

Each window is built using very advanced technologies to protect the sensitive fused silica glass panes from years of exposure to solar radiation and debris impacts.

The European-built Cupola which will offer astronauts a stunning perspective on the Earth below.

European ISS missions so far

Umberto Guidoni (Italy)
STS-100/ISS 2001

Claudie Haigneré (France)
Andromède/ISS 2001

Roberto Vittori (Italy)
Marco Polo/ISS 2002

Philippe Perrin (France)
STS-111/ISS 2002

Frank De Winne (Belgium)
Odissea/ISS 2002
OasISS/ISS 2009*

Pedro Duque (Spain)
Cervantes/ISS 2003

André Kuipers (Netherlands)
Delta/ISS 2004

Roberto Vittori (Italy)
Eneide/ISS 2005

Thomas Reiter (Germany)
Astrolab/ISS 2006

Christer Fuglesang (Sweden)
Celsius/ISS 2006
STS-128/ISS 2009*

Paolo Nespoli (Italy)
Esperia/ISS 2007
ISS 2010*

Leopold Eyharts (France)
Columbus/ISS 2007

Hans Schlegel (Germany)
Columbus/ISS 2007

*scheduled missions at time of printing

Exploiting a world without gravity

Paolo Nespoli on the Space Station in 2007.

The unique environment of the International Space Station (ISS) offers the opportunity for people to live and work in an orbiting laboratory in conditions of weightlessness.

This is important because gravity influences almost every biological, physical and chemical process on Earth - so taking it away allows us to discover why things happen in a certain way.

"The ISS provides an unprecedented opportunity to conduct research in a unique environment without gravity," said Simonetta Di Pippo, ESA's Director of Human Spaceflight.

"Over time it will promote a better understanding of many things, such as the growth cycles of plants, animals and the biology of humans – all leading to discoveries that may one day benefit people living on Earth.

"The Space Station is also an invaluable testbed for future technologies as well as being a laboratory for new, advanced industrial materials, communications technology, medical research and more," she added.

Applied research in space may lead to innovative or more efficient production techniques in steel and chemical factories, or power plants.

Even before the Space Station is fully completed, European scientists and engineers started imaginative research in medicine, materials development and new manufacturing processes.

Simonetta Di Pippo says that, following the installation of the Columbus laboratory and the launch of ESA's first ATV in 2008, the investments are beginning to pay off.

"We are now entering a phase where we can reap the fruits of our investment – technologically and scientifically – as well as using these systems to help us prepare for future exploration."

One vitally important aspect of the Space Station is the inspiration that having real people in space provides for school children and teenagers.

"Young people are inspired by astronauts and we know the work of Europeans on the Space Station will influence many children and students – encouraging more of them, we hope, to take up science, engineering and technology studies," she said.

Such an awe-inspiring project as the ISS was first discussed in 1984. Europe, Japan and Canada then joined a United States proposal in 1985. In 1993 Russia became the fifth partner.

ESA represents the 10 European countries currently supporting the ISS exploitation programme – Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Spain and Switzerland.

European astronaut team builds up expertise and experience

Members of ESA's astronaut corps are building their space expertise as members of long-duration International Space Station (ISS) crews and as participants in Space Shuttle missions.

The role they play is important for Europe, not only in gaining experience in the operations of the ISS but also as an investment for the future when perhaps one day Europeans will be among the first explorers to set foot on Mars.

Between 2006 and 2007 there were five missions with ESA astronauts, a busy period which also featured a number of historic 'firsts'.

These included German ESA astronaut Thomas Reiter becoming the first European to join an ISS Expedition crew (he was a flight engineer on the Expedition 13 and 14 crews, spending more than six months in orbit) and Swedish ESA astronaut Christer Fuglesang joining Reiter on the ISS in December 2006, the first time in the ISS's history that two Europeans were present on the Space Station together.

Hans Schlegel prepares equipment racks in Europe's Columbus module.

After the autumn 2007 flight of Paolo Nespoli together with Node 2, two ESA astronauts – Hans Schlegel and Leopold Eyharts – accompanied the Columbus module on a Space Shuttle mission in 2008.

After they oversaw its deployment and installation, Eyharts stayed on for several months to complete the laboratory's commissioning.

ESA astronaut Frank De Winne, from Belgium, is set to become the first European commander of the ISS later in the autumn of 2009 at the climax of his six month flight.

During the summer Christer Fuglesang, from Sweden, will arrive at the ISS on the Space Shuttle to assist on a space-walking construction and maintenance mission.

As the ISS expands to a permanent crew of six, the astronauts will be able to spend more of their time working on experiments.

ESA trains its own astronauts at the European Astronaut Centre (EAC) near Cologne in Germany, where it also instructs those from other countries in the operation of the European ISS elements such as Columbus and ATV.

How to view the ISS

The Space Station has now been orbiting the Earth over 15 times a day for almost 11 years – and the ESA website 'See the ISS' gives all the information needed to find the biggest and most powerful spacecraft ever built as it passes overhead.

Spotting the ISS with the naked eye is not as difficult providing you know in which direction to look. Thanks to its large solar wings it is one of the brightest 'stars' making it easy to distinguish as it moves across the night sky.

The ISS passes over most points on Earth everyday but cannot always be seen. The best time for ISS-gazing is just before dawn or just after sunset, when the observer is in the dark but the ISS is in the sun.

To find out the days and exact times the ISS is visible from your location visit: www.esa.int/seeiss

A new era of research and development

"Astronauts on the International Space Station (ISS) support research that covers everything from fundamental science to advanced technology and commercial product development," says Martin Zell, ESA's ISS utilisation programme manager.

Many studies and experiments are concerned with discovering the effects of gravity on biological, physical and chemical processes – and the implications this has for improving manufacturing processes on Earth.

The ISS provides astronomers and scientists studying our home planet with a flexible platform to perform measurements and make observations that are impossible from Earth's surface.

Although the motivation for many studies often begins with purely scientific interest, such questioning can quickly be taken up and successfully applied to practical problems.

Materials and combustion processes can also be studied more accurately in orbit than on Earth because of the absence of convection currents that cause fluids to mix.

When it comes to people, microgravity also changes the way the human body behaves – and studying such effects is already leading to insights into human health, disease prevention and treatment.

This includes the functioning of the heart, lungs and kidneys, which facilitates studies into cardiovascular disease, bone calcium loss (osteoporosis), muscle atrophy and hormonal disorders.

Some medical issues that have to be addressed for astronauts living in space can be related to the effects of ageing and immobility of patients.

And as European governments face up to the reality of ageing populations, such research may be crucial in helping to limit public health care spending in the future.

Equipment developed for keeping fit in space and for remotely monitoring astronaut health is also being increasingly adapted for use in hospitals and medical centres.

Through ESA and its European Programme for Life and Physical Sciences (ELIPS) the large European science community is actively pushing the boundaries of science and technology.

Europe, as the main scientific user of the ISS, will expand its international competitiveness in health research, innovative materials and processes to achieve important advances in plasma physics, exobiology, bone and muscle research, and metal alloys, to name but a few.

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